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Nomenclatural notes on the lichen genera *Leucodecton* and *Myriotrema* (*Graphidaceae*) in India

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Abstract —Nine species of *Leucodecton* and nine species of *Myriotrema* are recorded for India. The recently resurrected *Leucodecton* accommodates species earlier placed in *Leptotrema*, *Myriotrema,* or *Thelotrema,* which were segregated based primarily on medullary chemistry such as stictic and norstictic acids, although *Myriotrema* retains species with a prosoplectenchymatous cortex and psoromic or protocetraric acid chemosyndromes. This contribution includes new synonyms, changes in generic placement, new species distributions, and new records. *Leucodecton compunctum* and *L. subcompunctum* are new records for India.

Key words — thelotremoid, lepadinoid, taxonomy, delimitation, tropical, Western Ghats

Introduction

The evolving taxonomic and phylogenetic studies on crustose lichens have resolved numerous worldwide nomenclature fluxes and revealed many traditionally classified families as poly- or paraphyletic. This has improved the generic delimitation of *Graphidaceae,* the largest and core tropical microlichen family (Hale 1974, 1978, 1980, 1981; Frisch 2006; Staiger 2002; Rivas Plata et al. 2012). Rivas Plata et al. (2010) revised ca. 16 genera of thelotremoid *Graphidaceae* and provided a comprehensive account of more than 260 species excluding taxa of the *Ocellularia–Myriotrema–Stegobolus* clade.

Singh & Sinha (2010) cited 130 thelotremoid lichen species from India, of which the core group includes *Chapsa*, *Chroodiscus*, *Diploschistes*, *Fibrillithecis*, *Leptotrema*, *Leucodecton*, *Melanotrema*, *Myriotrema*, *Nadvornikia*, *Ocellularia,* *Reimnitzia*, *Stegobolus,* *Thelotrema*, *Topeliopsis,* and *Wirthiotrema*. Species delimitation within the genera is based on various morpho-anatomical

differences represented by thallus and apothecial morphology, photobiont, presence or absence of lateral paraphyses/fibrils and columella, ascospore color, excipulum anatomy and carbonization, substratum, and crystal arrangement (Frisch et al. 2006; Mangold et al. 2009; Rivas Plata et al. 2010).

Based on recent collections and the available literature (Nagarkar et al. 1986, 1987, 1988; Patwardhan & Kulkarni 1977a,b; Patwardhan & Nagarkar 1980; Patwardhan & Makhija 1980; Patwardhan et al. 1985; Sethy et al. 1987; Awasthi 1991, 2000; Frisch et al. 2006; Mangold et al. 2009; Rivas Plata et al. 2010; Singh & Sinha 2010), the present study provides a synopsis of the systematics, taxonomy, and distribution pattern of the lichen genera *Leucodecton* and *Myriotrema* in India according to the current generic classification within the *Graphidaceae*.

Materials & methods

We examined and re-determined specimens from Andaman & Nicobar Islands, Andhra Pradesh, Assam, Kerala, Orissa, Tamil Nadu and West Bengal that were stored in the herbarium of the National Botanical Research Institute (LWG). We also studied recent samples collected by one author (Haridas) from different localities in Western Ghats, India. Morpho-anatomical characters were studied using a Labomed Digizoom stereomicroscope and Leica DM500 light microscope. Thin hand-cut sections of apothecia and thallus were mounted in plain water, cotton blue, 10% KOH, and iodine solutions and observed under a compound microscope. For secondary metabolites identification spot tests, calcium hypochlorite (C) and paraphenylenediamine (PD) were also applied when needed. TLC (solvent system A & C) was performed following Orange et al. (2001).

We assembled preliminary information on Indian thelotremoids from the literature (Nagarkar et al. 1986, 1987, 1988; Patwardhan & Kulkarni 1977a,b; Patwardhan & Nagarkar 1980; Patwardhan & Makhija 1980; Patwardhan et al. 1985; Sethy et al. 1987; Awasthi 1991, 2000; Singh & Sinha 2010). Earlier generic concepts and identification keys were revised according to recent world monographs based on modern concepts and classification (Frisch et al. 2006; Mangold et al. 2009; Rivas Plata et al. 2010).

Taxonomy

Leucodecton A. Massal., Atti Reale Ist. Veneto Sci. Lett. Arti, ser. 3, 5: 325, 1860.

The recently resurrected genus *Leucodecton*, originally introduced for a single species, *L. compunctum*, currently contains ca. 19 species worldwide. This includes five species each for Africa (Frisch 2006) and Australia (Mangold et al. 2009) and six from India, with one (*L. tarmuguliense*) apparently endemic for the country (Singh & Sinha 2010), although additional sampling is needed to confirm the endemism of this species. By adding three more taxa, our re-evaluation of the Indian thelotremoids brings to nine the number of *Leucodecton* species represented in the country. Taxonomic and systematic revision of the

thelotremoid *Graphidaceae* has broaden the generic delimitations so that the genus now accommodates several stictic and norstictic acid-containing species earlier placed in *Leptotrema*, *Myriotrema,* and *Thelotrema*. *Leptotrema* is separated from *Leucodecton* based on its apically thickened asci and thick-walled ascospores, while *Myriotrema* has parallel hyphae with radiating tips in the proper exciple and belongs to a separate molecular clade (Frisch et al. 2006). *Thelotrema,* on the other hand, acquires a periphysoidal excipulum. *Leucodecton* has been re-introduced to accommodate species characterized by apothecioid ascomata and a ± free proper exciple of distinctly paraplectenchymatous hyphae lacking radially oriented tips, markedly interwoven and often scarcely branched paraphyses, absence of lateral paraphyses, ± muriform brown usually I– ascospores, and presence of stictic or norstictic acids (Frisch 2006; Mangold et al. 2009; Rivas Plata et al. 2010).

Key to *Leucodecton* species recorded from India

1a. Ascospores 10–50 µm long, (2–)4–8 per ascus. 2
1b. Ascospores >50 µm long, 1–4 per ascus 6
2a. Norstictic acid present . . . . . ***L. occultum***
2b. Stictic acid present 3
3a. Apothecia often aggregated in whitish pseudostromata, thallus ecorticate . . . . . ***L. glaucescens***
3b. Apothecia solitary (sometimes numerous), thallus corticate (loose to irregular or prosoplectenchymatous) 4
4a. True cortex present, thallus hard to crystalline, ascospores 15–27(–33) µm long . . . . . ***L. compunctum***
4b. True cortex absent, thallus loose, ± dull, ascospores 20–40 µm long. 5
5a. Apothecia lepadinoid with free excipulum . . . . . ***L. subcompunctum***
5b. Apothecia myriotremoid, with ± fused excipulum . . . . . ***L. fissurinum***
6a. Ascospores remaining hyaline . . . . . ***L. anamalaiense***
6b. Ascospores brown on maturity. 7
7a. Apothecia myriotremoid to ocellularioid, thallus with irregular clusters of crystals. . . . . ***L. tarmuguliense***
7b. Apothecia porinoid to myriotremoid, thallus often with large columnar clusters of crystals. 8
8a. Apothecia porinoid (to indistinctly myriotremoid or lepadinoid with an apically free exciple), narrow pore surrounded by dark ring . . . . . ***L. compunctellum***
8b. Apothecia myriotremoid with narrow pore, thallus with small ± irregularly dispersed crystals, narrow pore surrounded by white ring. . . . . ***L. nuwarense***

Leucodecton anamalaiense (Patw. & C. R. Kulk.) Rivas Plata & Lücking, Lichenologist 42: 184, 2010.

Patwardhan & Kulkarni (1977b) first described this species from Anamalai hills in Kerala as *Thelotrema anamalaiense*. However the lepadinoid apothecia, brownish excipulum lacking lateral paraphyses, 2–4-spored asci, muriform hyaline ascospores of 50–80 × 15–20 µm, and presence of stictic acid chemosyndrome agree well with *Leucodecton,* to which it was recently transferred. The closely related *L. nuwarense* differs only in small ascospores that turn brown at late maturity (Rivas Plata et al. 2010).

Leucodecton compunctellum (Nyl.) Frisch, Biblioth. Lichenol. 92: 155, 2006.

= *Leptotrema microglaenoides* (Vain.) Zahlbr., Cat. Lich. Univers. 2: 637, 1923

= *Leptotrema elachistoteron* (Leight.) Patw. & C. R. Kulk, Norweg. J. Bot. 24: 128, 1977

= *Leptotrema oligosporum* (Müll. Arg.) Patw. & Makhija, Bryologist 83: 368, 1980

= *Myriotrema elachistoteron* (Leight.) Hale, Mycotaxon 11: 133, 1980

= *Myriotrema reclusum* (Leight.) Hale, Mycotaxon 11: 135, 1980

The species is diagnosed by pale yellowish-grey to straw colored, finely rugose to verrucose surface thallus with large columnar clusters of crystals, a fused proper exciple, porinoid apothecia with very small pores (ca. 0.05 mm), 1–4-spored asci, and brown ascospores up to 140 µm long.

Leucodecton compunctellum has previously been reported from India as *Leptotrema elachistoteron*, *L. microglaenoides*, *L. oligosporum*, *Myriotrema elachistoteron,* and *M. reclusum* (Patwardhan & Makhija 1980; Nagarkar et al. 1986; Awasthi 1991; Singh & Sinha 2010; Mangold et al. 2010). Its distribution ranges from Andaman Islands to Karnataka and Kerala.

Specimens examined—**INDIA. Andaman & Nicobar Islands:** Unknown Island, near evergreen forest compound, on bark, 23.04.1961, A. Singh 79745 (LWG); **Kerala:** Idukki district, I.C.R.I. campus, Myladumpara, alt. ca. 1200 m, on bark of tree, 01.03.1984, D.D. Awasthi & G. Awasthi 84.116 (LWG).

Leucodecton compunctum (Ach.) A. Massal., Atti Inst. Veneto Sci. lett., Arti, ser. 3, 5: 325, 1860. Plate 1a

Thallus corticolous, epiphloeodal, greenish-grey to yellowish-green or olive-green, glossy, crystalline, smooth, continuous, 114–142 µm thick. True cortex well developed, 15–25 µm thick. Prothallus indistinct, brownish. Photobiont layer inspersed with crystals largely dispersed to aggregate. Medulla indistinct to endophloeodal. Apothecia solitary, immersed, perithecioid, round, small to ca. 1.0 mm in diam. Pore minute, round, blackish, 0.2–0.3 µm in diam. Margin thick, entire, often brighter than the thallus. Disc not visible from above. Proper exciple, pale yellowish to brownish, laterally 20–25 µm reaches up to 62(–80) µm in the bottom. Epihymenium hyaline, without granules, 10–20 µm high. Hymenium clear, 150–200 µm high. Paraphyses simple, ±straight, delicate, conglutinate apically, 1–2 µm thick. Asci 8-spored, clavate, 50–70 × 15–20 µm.

Ascospores becoming brown at early maturity, muriform, 6–13 × 4–6 loculate, oblong to subglobose, 23–27(–33) × 11–14(–16) µm in size, endospore thick, I–.

Chemistry: K+ reddish, C–, PD+ orange; stictic acid chemosyndrome detected in TLC.

Ecology & distribution: Worldwide, *L. compunctum* is widely distributed in the tropics, although not recorded from Africa (Frisch et al. 2006). Newly recorded for India, it is known from tropical evergreen forests of Western Ghats above 1000 m, spreading in large thallus patches closely associated with *L. subcompunctum* and *Wirthiotrema glaucopallens* (Nyl.) Rivas Plata & Kalb.

Specimen examined— **INDIA. Kerala:** Kollam district, Rosemala, on bark, 27.06.2006, Biju Haridas 06–009582 (LWG).

Remarks: *Leucodecton compunctum* is characterized by a rather glossy smooth to crystalline thallus, immersed perithecioid apothecia with minute pores, and brown muriform ascospores. It is readily distinguished from *Leptotrema wightii* (Taylor) Müll. Arg. in lacking red anthraquinone crystals and from *Leucodecton compunctellum* and *L. subcompunctum* in having smaller ascospores. Moreover, *L. subcompunctum* has lepadinoid apothecia. *Leucodecton compunctum* may sometimes be confused with *Wirthiotrema glaucopallens* excluding pore structures; *W. glaucopallens* is further distinguished by a *Myriotrema*-type prosoplectenchymatous cortex with internal splitting (Rivas Plata et al. 2010).

Leucodecton fissurinum (Hale) Frisch, Biblioth. Lichenol. 92: 156, 2006.

A regularly fissured areolate thallus, compact surface, fused to incompletely free proper exciple bordering the rounded pore as a brownish ring, and myriotremoid apothecia are the major characters separating *L. fissurinum* from the closely related *L. subcompunctum*. Further differences are the 8-spored asci and brown muriform (3–10 × 1–3 septate) ascospores of 20–40 × 9–13 µm.

The species has been recorded at higher altitudes from Africa (Frisch 2006) and Sri Lanka (Hale 1981). In India this species was reported as *Myriotrema fissurinum* (Awasthi 1991; Singh & Sinha 2010) and is distributed mostly in the south, including Karnataka, Kerala, Tamil Nadu, and West Bengal.

Specimens examined—**INDIA. Kerala:** Idukki district, I.C.R.I. campus, Myladumpara, alt. ca. 1200 m, on bark, 01.03.1984, D.D. Awasthi & G. Awasthi 84.103 (LWG-LWU); **Tamil Nadu:** Nilgiri Hills, Avalanche, Hatchery Shola, alt. ca. 2100 m, on bark, 23.12.1971, K.P. Singh 71.564 (LWG-LWU); **West Bengal:** Eastern Himalaya, Darjeeling district, Rangit river valley, Rangit, near the bridge, alt. ca. 600 m, on bark, 08.03.1967, D.D. Awasthi & M.R. Agarwal 67.185 (LWG-LWU).

Leucodecton glaucescens (Nyl.) Frisch, Biblioth. Lichenol. 92: 164, 2006.

This taxon can easily be recognized by the chroodiscoid-lepadinoid apothecia aggregated in whitish pseudostromata, ± free proper exciple, 8-spored asci, and small brown muriform ascospores mostly under 20 × 10 µm.

Awasthi (1991) reported the species as *Myriotrema glaucescens*. The closely related *L. phaeosporum*, *L. subcompunctum,* and *L. fissurinum* have a loosely corticate thallus, mostly solitary apothecia, and comparatively larger ascospores. *L. glaucescens* occurs in tropical forests of Karnataka, Kerala, and Tamil Nadu.

Specimens examined— **INDIA. Kerala:** Palghat district, M.C.L. mines area, Walayar forest, alt. ca. 300 m, on bark, 22.03.1985, D.D. Awasthi, R. Tewari & R. Mathur 85.35, 85.3 (LWG-LWU); Idukki district, Munnar, Rajamallay area, alon border of tea plantation, alt. ca. 1500–1600 m, on bark, 24.03.1985, D.D. Awasthi, R. Tewari & R. Mathur 85.55 (LWG-LWU); on way Myladumpara to Munnar, Chinnakanal area, alt. ca. 1350 m, on bark, 02.03.1984, D.D. Awasthi & G. Awasthi 84.251 (LWG-LWU).

Leucodecton nuwarense (Hale) Frisch, Biblioth. Lichenol. 92: 155, 2006.

The species is recognized by a pale greenish-grey uneven cracked thallus containing stictic acid chemosyndrome, numerous immersed apothecia, free proper exciple, 2-spored asci, and brown muriform ascospores of 42–55 × 10–15 µm.

Originally included in Indian thelotremoid group as *Leptotrema nuwarense* and *Myriotrema nuwarense* from South Andaman (Nagarkar et al. 1986; Awasthi 1991), *L. nuwarense* is close to *L. anamalaiense,* which is distinguished by consistently hyaline and somewhat larger ascospores.

Leucodecton occultum (Eschw.) Frisch, Biblioth. Lichenol. 92: 157, 2006.

= *Leptotrema compunctum* (Ach.) Nyl., Flora 71: 527, 1888

= *Leptotrema norstictideum* Patw. & Nagarkar, Biovigyanam 6(1): 5, 1980

This species is described for an ecorticate fissured thallus in different shades of pale and yellow (greenish or grey), immersed to slightly emergent ascomata with a free proper exciple, small brown submuriform or muriform (5–9 × 1–5 septate), thick-walled ascospores (20–40 × 10–17 µm), and presence of norstictic acid chemosyndrome.

Awasthi & Singh (1975) and Patwardhan & Kulkarni (1977a) cited *L. occultum* as *Leptotrema compunctum*, and Patwardhan & Nagarkar (1980) as *Leptotrema norstictideum*. In India the species is found in the Andaman and Nicobar Islands, Andhra Pradesh, Assam, Kerala, Madhya Pradesh, Meghalaya, Orissa, Tamil Nadu, and West Bengal. It is the only norstictic acid (major) containing species of *Leucodecton*.

Specimens examined—**INDIA. Andhra Pradesh:** Vishakhapatnam, Simhachadam area in cashew plantation, on bark of Mango tree, 06.03.1986, D.D. Awasthi, G. Awasthi, R. Mathur & P. Srivastava 86.240, 86.248 (LWG-LWU); **Kerala:** Trivandrum Botanical and Zoological Garden, on bark, 08.05.1979, D.D. Awasthi, D.K. Upreti & U. Mishra 79.898 (LWG-LWU); **Orissa:** Ganjam district, on way to Seranga, on bark of *Pongamia* tree, 03.03.1986, D.D. Awasthi, G. Awasthi, R. Mathur & P. Srivastava 86.128 (LWG-LWU); **West Bengal:** 24 Parganas district, Sunderban, Sajanakholi forest office, on bark, May 1975, K. N. Roychowdhury 3871, 3862, 3875, 3879 (LWG-CAL).

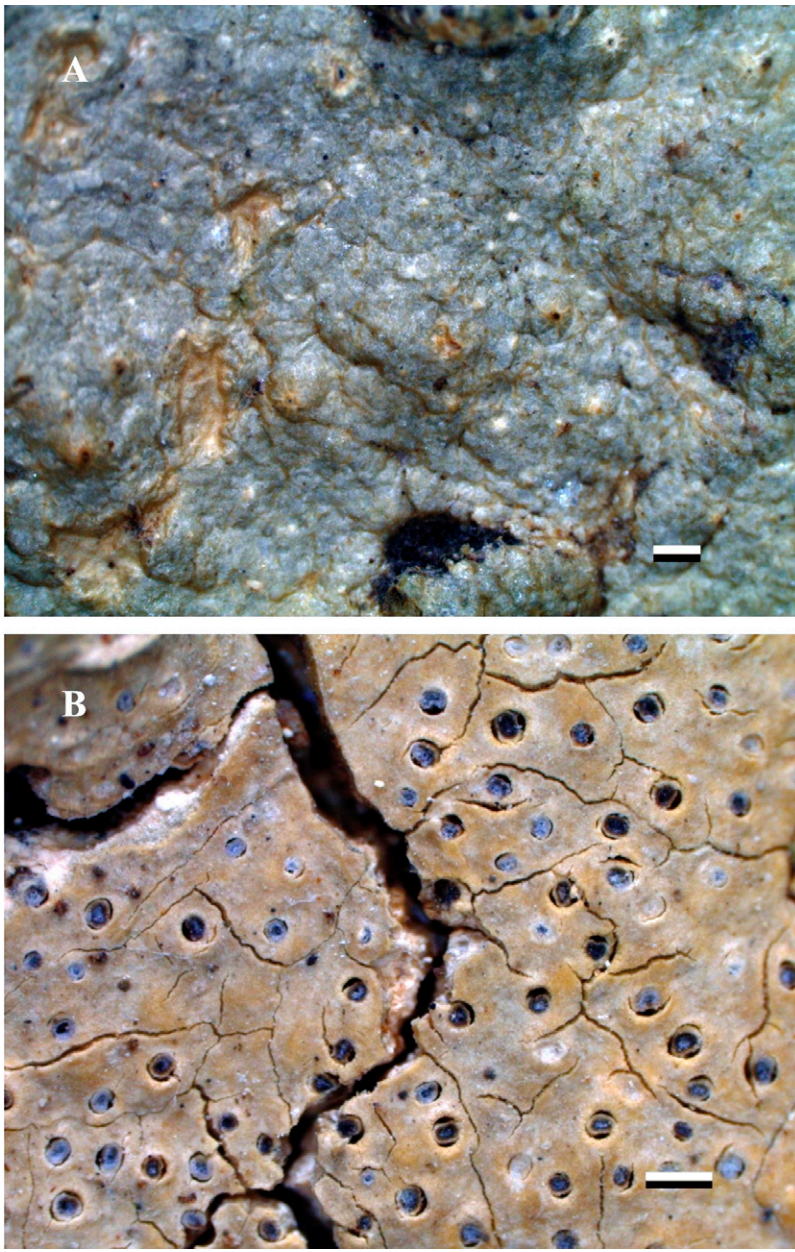

Plate 1. New *Leucodecton* records from India.
A. *Leucodecton compunctum*. B. *Leucodecton subcompunctum*.
Scale bars: A = 1 mm; B = 2 mm.

Leucodecton subcompunctum (Nyl.) Frisch, Biblioth. Lichenol. 92: 162, 2006.

Plate 1b

Thallus corticolous, epiphloeodal, olive-grey to olive-brown, fissured to areolate, ± glossy, loose, irregularly corticate, crystalline surface. Prothallus brownish. Photobiont layer well developed, with inclusions of calcium oxalate crystals, up to 50 µm thick. Medulla largely endophloeodal. Apothecia dispersed, immersed, rounded to angular, up to 1.0 mm wide pore. Disc blackish, usually covered with white pruina. Proper exciple free to partly fused, pale fawn to sometimes hyaline, 15–25 µm thick. Epihymenium unpigmented, up to 10 µm high. Hymenium clear, 100–120 µm high. Subhymenium 10–20 µm high. Paraphyses simple, straight, 1.5–2.0 µm thick, tips slightly thickened, adspersed with grayish granules. Asci 8-spored, narrowly clavate, 80–100 × 10–20 µm in size. Ascospores brown, muriform, 3–8 ×1–3 septate, 15–35 × 10–20 µm in size, I–.

Chemistry: K+ reddish, PD+ orange, C–. Stictic acid chemosyndrome detected in TLC.

Ecology & distribution: Previously known from tropical, sub-tropical to temperate regions in Africa, Asia, and Australia (Frisch 2006), *L. subcompunctum* is reported for the first time from India from the tropical evergreen forests of Western Ghats (Kerala and Tamil Nadu). It can grow in shade but is found mostly in open sub-temperate forests and avoids humid environment.

Specimens examined— **India. Kerala:** Idukki district, Kallar Munnar Hills, alt. 1140 m, on bark, 14.02.1975, A. Singh & M. Ranjan 103044 (LWG); Trivendrum, ABP, way to Pongalappara, alt. 1150 m, on bark, 26.04.2006, Biju Haridas 06–009580 (LWG); **Tamil Nadu:** Nilgiri Hills, Kodanad, tea estate area, alt. ca. 2019 m, on bark, 31.12.1970, D.D. Awasthi & K.P. Singh 70.1447, 70.1500 (LWG-LWU); In the shola near tea estate, alt. ca. 2010 m, on bark, 31.12.1970, D.D. Awasthi & K.P. Singh 70.1499 (LWG-LWU); Salem district, Yercaud, Shevaroy Hills, near Shevaroy temple, alt. 1600 m, on bark, 29.12.1990, D.K. Upreti & Hariharan 202308 (LWG); Palni Hills, Kodaikanal, near Shola, alt. ca. 1800 m, on bark, 13.12.1970, K.P. Singh, 70.849 (LWG-LWU).

Remarks: Frisch (2006) considered *L. subcompunctum* a lowland species and separated it from the customarily high elevation *L. fissurinum* based on altitudinal range and certain minor diagnostic differences. But the recent field survey together with the re-examination of preserved material indicates that in India *L. subcompunctum* occurs at significantly higher altitudes in montane forests. However, the compact crystalline irregularly fissured to areolate thallus and lepadinoid apothecia with free excipula separate *L. subcompunctum* from *L. fissurinum*. *Leucodecton phaeosporum* (Nyl.) Rivas Plata & Lücking, which resembles *L. subcompunctum* in having a loose and irregular cortex, differs in columnar crystal arrangement in the thallus and comparatively small ascospores of 15–25 µm.

Leucodecton tarmuguliense (Sethy, Nagarkar & Patw.) Frisch, Biblioth. Lichenol. 92: 155, 2006.

The species is characterized by a pale yellowish-grey to olivaceous thallus containing stictic acid chemosyndrome, prominent apothecia, a fused proper exciple, 2-spored asci and brown muriform ascospores of 70–93 × 15–23 µm. Sethy et al. (1987) described this species as *Leptotrema tarmuguliense* from south Andaman, which was accommodated in *Myriotrema* (Awasthi 1991) until the recent thelotremoid taxonomic reclassification. The species is well separated from the closely related *L. compunctellum* by its prominent (emergent) apothecia and irregular clusters of crystals. An Indian endemic, *L. tarmuguliense* is reported thus far only from Andaman and Nicobar Islands.

Myriotrema Fée, Essai Crypt. Écorc. 1: xlix, 103, 1825.

The genus, recognized as a section in *Thelotrema* (Salisbury 1978), was reestablished by Hale (1980, 1981) to accommodate species that lack lateral paraphyses and have non-carbonized proper exciples. Frisch et al. (2006) later revised *Myriotrema* for six species in Africa and Mangold et al. (2009) for 17 species in Australia. Worldwide ca. 25 *Myriotrema* species were recognized prior to emendation by Rivas Plata et al. (2010), who circumscribed the genus to emphasize the internally splitting prosoplectenchymatous cortex and production of psoromic and protocetraric chemosyndromes. In India the genus was represented by 24 species (Awasthi 1991, 2000), subsequently reduced to 15, including three endemics (Singh & Sinha 2010). Due to the most recent generic classification, most *Myriotrema* taxa have been transferred to *Chapsa, Leucodecton*, *Ocellularia, Thelotrema,* and *Wirthiotrema,* with some reduced to synonymy. Currently *Myriotrema* is represented in India by nine species (including one endemic) featuring psoromic acid as a major chemical constituent with some species containing protocetraric acids and unknown compounds. Other diagnostic characters include an internally splitting prosoplectenchymatous cortex, small myriotremoid apothecia, prosoplectenchymatous proper exciples with radiating tips, and an absence of lateral paraphyses.

Key to *Myriotrema* species recorded from India

1a. Ascospores muriform to submuriform 2
1b. Ascospores transversely septate (sometimes with 1 vertical septum) 5
2a. Ascospores brown . . . . . ***M. desquamans***
2b. Ascospores hyaline 3
3a. Lichen substances absent . . . . . ***M. subconforme***
3b. Lichen substances present (psoromic acid) 4

4a. Asci 4–8-spored, ascospores small, 15–25 × 7–10 µm ..... ***M. rugiferum***
4b. Asci 1-spored, ascospores large, 140–240 × 24–50 µm ..... ***M. masonhalei***
5a. Thallus containing protocetraric acid present ..... ***M. pertusarioides***
5b. Thallus lacking protocetraric acid 6
6a. Apothecia usually emergent, psoromic acid chemosyndrome .....***M. glaucophaenum***
6b. Apothecia immersed to raised, chemistry variable 7
7a. Thallus containing olivaceum unknown .....***M. olivaceum***
7b. Thallus containing psoromic acid chemosyndrome 8
8a. Thallus glossy, ± free proper exciple, ascospores usually with 1 vertical septum.....***M. clandestinum***
8b. Thallus fissured, areolate, ± fused proper exciple, ascospores consistently transversely septate .....***M. microporum***

Myriotrema clandestinum (Fée) Hale, Mycotaxon 11: 133, 1980.
= *Ocellularia terebratula* (Nyl.) Müll. Arg., Mém. Soc. Phys. Genève 29(8): 12, 1887

The species is characterized by pale greenish to olivaceous corticate continuous glossy thallus, immersed apothecia, ± free proper exciple, small hyaline transversely 5–6-septate (with one vertical septum) ascospores of 10–27 × 6–8 µm, and the presence of psoromic acid.

Myriotrema clandestinum, reported from India by Nagarkar et al. (1988) as *Ocellularia terebratula*, has been included in the synonymy of *Myriotrema clandestinum* by Mangold et al. (2009). It has a wide distribution in India and collected from Andaman & Nicobar Islands, Arunachal Pradesh, Karnataka, Kerala, Maharashtra, and Meghalaya.

Specimens examined—**INDIA. Kerala:** Mallapuram district, Wynad area, Thakarpadi, A. Singh & M. Ranjan, alt. 450 m, on bark 102217 (LWG); Trivendrum Peppara Wildlife Sanctuary, on bark, 19.10.2006, Biju Haridas, 06–009586 (LWG); Kollam, Rosemala, 27.6.2006, on bark, B. Hardas, 06–009585 (LWG); **Tamil Nadu:** Palni Hills, Perumal to Palni road side, via short-cut road, alt. 1350–1500 m., on bark, 15.12.1970, K.P. Singh 70.984 (LWG).

Myriotrema desquamans (Müll. Arg.) Hale, Mycotaxon 11: 133, 1980.
= *Leptotrema irosinum* (Vain.) Zahlbr., Cat. Lich. Univ. 2: 635, 1923

The taxon is characterized by a glossy corticate thallus, small-pored immersed perithecioid ascomata, a fused proper exciple, and brown muriform (5–11 × 1–6 septate) ascospores of 20–35 × 8–18 µm.

In India the species was reported as *Leptotrema desquamans* by Patwardhan & Makhija (1980) and *L. irosinum* by Patwardhan & Kulkarni (1977a). The species shows close affinity with *Wirthiotrema* and forms a non-inspersed counterpart of *W. trypaneoides* (Nyl.) Rivas Plata & Lücking (Rivas Plata et al.

2010). In India the species is known from Andaman & Nicobar Islands and Kerala.

Myriotrema glaucophaenum (Kremp.) Hale, Mycotaxon 11: 133, 1980.

The greenish to yellowish-grey thallus, ± free proper exciple, emergent apothecia, 8-spored asci, transversely 1–7 septate (with single vertical septum) hyaline ascospores of 10–20 × 5–8 µm, and presence of psoromic acid are the characteristic features of the species. The closely related *M. microporum* and *M. clandestinum* with psoromic acid differs in having a fissured thallus and a fused proper exciple, respectively. *Myriotrema glaucophaenum* is unusual in its *Thelotrema*-like ascomata that lack lateral paraphyses (Mangold et al. 2009). Patwardhan & Kulkarni (1977a) reported the species from Kerala as *Ocellularia glaucophaena*.

Specimen examined—**INDIA. Kerala:** Trivendrum, ABP, Athirumala Pathalamathy, alt. 1200 m, on bark, 25.04.2006, Biju Haridas 06–009587 (LWG).

Myriotrema masonhalei (Patw. & C. R. Kulk.) Hale, Mycotaxon 11: 134, 1980.

The species is diagnosed by the dark greenish glaucous, wrinkled to warty thallus, immersed apothecia, a pale-brown fused proper exciple carbonized at apices, 1-spored asci, and oblong-ellipsoid, large (140–240 × 24–50 µm) ascospores.

This psoromic acid containing species is described from Maharashtra by Patwardhan & Kulkarni (1977) as *Thelotrema masonhalei* and has also been reported from Kerala and Karnataka in Western Ghats in India (Singh & Sinha 2010).

Myriotrema microporum (Mont.) Hale, Mycotaxon 11: 134, 1980.

The taxon is readily recognized by a thick areolate fissured dark dull-grey thallus, numerous small apothecia, a ± fused proper exciple, 8-spored asci, transversely 2–4-septate hyaline ascospores of 10–18 × 5–8 µm, and the presence of psoromic acid chemosyndrome.

Myriotrema microporum shares the same chemical constituents with *M. clandestinum* and *M. glaucophaenum* but differs in the distinctly fissured, areolate thallus and slightly small transversely septate ascospores. Earlier it was reported as *Ocellularia micropora* from Assam, Karnataka, Kerala, Orissa, Tamil Nadu, and West Bengal (Nagarkar et al. 1988, Singh & Sinha 2010). The species is found in Western Ghats, eastern Himalayas, and Eastern Ghats in India.

Specimens examined—**INDIA. Assam:** North Cachar Hills district, Haflong, on bark, D.K. Upreti & Jayshree Rout 05–002992 (LWG); **Kerala:** Idukki district, I.C.R.I. campus, Myladumpara, alt. ca. 1200 m, on bark, 01.03.1984, D.D. Awasthi & G. Awasthi 84.118, 84.148 (LWG-LWU); on bark of *Vateria indica*, 01.03.1984, D.D. Awasthi & G. Awasthi 84.128 (LWG-LWU); Myladumpara to Munnar, Chinnakanal area, alt. ca.

1350 m, on bark, 02.03.1984, D.D. Awasthi & G. Awasthi 84.228, 84.248 (LWG-LWU); Santhampara area, alt. ca. 1200 m, on bark, 02.03.1984, D.D. Awasthi & G. Awasthi 84.177 (LWG-LWU); Kallar Munnar Hills, alt. 1140 m, on bark, 14.02.1975, A. Singh & M. Ranjan 103065 (LWG); Travancore, Quilon, on bark, 10.08.1953, O.A. Höeg 2580 (LWG-AWAS); **Orissa:** Ganjam district, on way to Seranga, on bark of *Pongamia* tree, 03.03.1986, D.D. Awasthi, G. Awasthi, R. Mathur & P. Srivastava 86.127 (LWG-LWU); **Tamil Nadu:** Palni Hills, Perumal to Palni road side, via short cut road, alt. 1350–1500 m, on bark, 15.12.1970, K.P. Singh 70.981 (LWG-LWU); Tiger Shola area, along the road, alt. ca. 1650 m, on bark, 15.12.1970, K.P. Singh 70.1028 (LWG); Shembaganur to Periakulum, via short cut road, alt. 1650–1800 m, on bark, 14.12.1970, K.P. Singh 70.935 (LWG-LWU).

Myriotrema olivaceum Fée, Essai Crypt. Écorc. 1: 103, 1825.

The taxon is distinguished by the thallus compound "olivacea unknown," a light greenish-grey to ashy grey smooth fissured areolate thallus, free proper exciple, 8-spored asci, and small (10–15 × 5–7 µm) transversely 2–4-septate ascospores.

The unusual chemical compounds separate the species from the closely related *M. microporum*, which has similar apothecial morpho-anatomical characters. Nagarkar et al. (1986) reported *M. olivaceum* (as *Ocellularia olivacea*) from Andaman and Nicobar Islands, the only sites reported for India.

Myriotrema pertusarioides (Nagarkar, Sethy & Patw.) D.D. Awasthi, Biblioth. Lichenol. 40: 3, 1991.

The species is characterized by a pale to yellowish-grey warty thallus, numerous emergent basally constricted apothecia, a fused reddish-yellow proper exciple, 8-spored asci, and 15–18 × 10–12 µm ascospores with single transverse and vertical septa.

Nagarkar et al. (1986) described this protocetraric acid-containing species (as *Leptotrema pertusarioides*) from the Andaman and Nicobar Islands, where it appears endemic. However, further taxonomic study is needed, as its apothecial morphology is unusual for the genus, and it resembles *Ocellularia bahiana* (Ach.) Frisch in having protocetraric acid.

Myriotrema rugiferum (Harm.) Hale, Mycotaxon 11: 135, 1980.

This morphologically variable taxon is characterized by a pale-olive to greyish and greenish-white thick corticate thallus, small immersed apothecia, a free proper exciple, 4–8-spored asci, and small (15–25 × 7–10 µm) hyaline submuriform (3–6 × 0–3 septate) ascospores. Similar to *M. masonhalei, M. rugiferum* contains psoromic acid but differs in having 1-spored asci and large ascospores. *Myriotrema rugiferum* has been collected only from tropical forests of Kerala in India.

Specimens examined—**INDIA. Kerala:** Idukki district, I.C.R.I. campus, Myladumpara, alt. ca. 1200 m, on bark, 01.03.1984, D.D. Awasthi & G. Awasthi 84.136, 84.73, 84.83 (LWG-LWU).

Myriotrema subconforme (Nyl.) Hale, Mycotaxon 11: 135, 1980.

Distinguishing features include a pale-olive to greyish-green or greenish-grey verruculose rather fragile corticate thallus with numerous crystals inclusions, a free proper exciple, 8-spored asci, and small (10–20 × 6–9 µm) submuriform (3–5 × 1–3 septate) ascospores.

Myriotrema subconforme appears most closely related to *M. album* Fée, *M. clandestinum*, *M. myrioporum* (Tuck.) Hale, and *M. endoflavescens* Hale ex Lücking in lacking thallus compounds. However, all three species differ from *M. subconforme* in their mostly transversely septate ascospores, and *M. endoflavescens* has a yellow-pigmented medulla (Lumbsch et al. 2011). The submuriform species, *M. rugiferum*, contains psoromic acid and has slightly larger (ca. 0.4 mm) apothecia (Mangold et al. 2009).

Nagarkar et al. (1987) reported *M. subconforme* (as *Thelotrema subconforme*) from Andaman and Nicobar Islands. Reexamination of certain unidentified preserved specimens from Kerala has extended the range of this species to Western Ghats.

Specimens examined—**INDIA. Kerala:** Palghat district, M.C. mines area, Walayer forest, alt. ca. 300 m, on bark, 22.03.1985, D.D. Awasthi, R. Tewari & R. Mathur 85.8 (LWG-LWU); Kollam district, rosemala, on bark, 28.06.2006, Biju Haridas 06–009588 (LWG); Trivendrum, ABP, way to Pongalappara, alt. 1145 m, on bark, 26.04.2006, Biju Haridas 06-009625 (LWG); **Tamil Nadu:** Nilgiri Hills, Awalanche, in Shola near forest rest house, alt. ca. 2100 m, on bark, 04.01.1971, D.D. Awasthi & K.P. Singh 71.247 (LWG-LWU).

Discussion

The *Graphidaceae* flourish well in India and offer a remarkable diversity in Andaman & Nicobar Islands, eastern Himalayas, and Western Ghats. Of the 18 taxa studied here, 14 species (seven each of *Leucodecton* and *Myriotrema*) occur in Western Ghats, followed by nine (four *Leucodecton* and five *Myriotrema*) reported from Andaman & Nicobar Islands and four species (two each of *Leucodecton* and *Myriotrema*) from eastern Himalayas. Eastern Ghats harbours *Leucodecton occultum* and *Myriotrema microporum* whereas central India is represented by *Leucodecton occultum*. Despite the variations in macro-habitat, tree species, trunk girth, bark texture, and other microclimate variables, it is noteworthy that thelotremoid lichens exhibit a uniform pattern of association with other lichens on different trees of tropical rain forests in India. Although placed in significantly different clades by molecular analysis, *Leucodecton* and *Myriotrema* especially show morphological similarities and share habitats

over a broad (300–2100 m) altitudinal range. *Leucodecton* mostly inhabits the wide tree trunks and associates with other porinoid or lepadinoid species (e.g., *Myriotrema*, *Ocellularia, Thelotrema* and *Wirthiotrema*) in comparatively dry but shaded undisturbed to semi-disturbed mature secondary lowland forests. Ecorticate taxa retain their rough texture that easily distinguishes them from neighbouring corticate taxa. However, the corticate shiny hard texture of certain *Leucodecton* taxa is so close to some *Myriotrema* and *Ocellularia* species that field identification is difficult. Superficially, the thallus and apothecial structures in some *Leucodecton* species (e.g., *L. compunctellum*) are enough similar to those in certain *Myriotrema* species that chemical tests are needed for correct determination.

Thelotremoid lichens in India are in great need of systematic revision due to remaining taxonomic and nomenclatural problems. In certain cases the taxonomically functional characters for species differentiation are not very sharp (Staiger et al. 2006, Rivas Plata & Lumbsch 2011). In particular, delimiting species based on ascospore color changing progressively from hyaline to brown during development is overemphasized, as for *Leucodecton anamalaiense*, *L. compunctellum,* and *L. nuwarense*. Differentiation between *L. compunctellum* and *L. nuwarense* is based broadly on crystal arrangement and color of the pore margins, with separation of the two dependent on rather similar characteristics of apothecia, pore structures, size, and thallus texture (Rivas Plata et al. 2010). Further, *L. fissurinum* is treated as a separate species based on such minor taxonomic features as a regularly fissured thallus and myriotremoid apothecia with ± fused exciple. The closely related *L. subcompunctum,* which also exhibits a fissured thallus, does have a diagnostic lepadinoid apothecial morphology. Likewise, *Myriotrema clandestinum* differs from *M. microporum* in its somewhat smooth thallus, ± fused proper exciple, and ascospores with a single vertical septum. The closely related *M. microporum* has a fissured thallus, ± free proper exciple, and transversely septate ascospores within the range of *M. clandestinum* (Mangold et al. 2009). Species delimitation based on vertical septum as suggested by Salisbury (1978) has little taxonomic significance. Moreover, characters like a fissured thallus, a more or less free to fused excipulum, the arrangement or abundance of crystals, or the involvement of a periderm layer in the apothecial margins (Frisch 2006; Mangold et al. 2009; Rivas Plata et al. 2010) seem to have little taxonomic importance and should be considered ecologically influenced variations. Nonetheless, it might be beneficial to know whether such morphological variations result from genetic differentiation or phenotypic plasticity (Rivas Plata & Lumbsch 2011, Rivas Plata et al 2011).

The unrevised taxa, *M. masonhalei* and *M. pertusarioides,* both with 1-spored asci, are currently placed in *Myriotrema*. Occurrence of a single spore is rare in *Myriotrema.* Furthermore, the ascospore size in *M. masonhalei* is unusually

large for *Myriotrema*, while the basally constricted emergent apothecia in *M. pertusarioides* seems more characteristic of *Ocellularia,* indicating that both species need further analysis for proper placement. Several thelotremoid taxa have uncertain positions in either molecular or traditional taxonomic classification, suggesting that they need to be split into several different taxa or delimited more broadly to resolve ambiguities at the generic or species levels.

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